MICROSCOPY.[1]

MODE OF PRODUCTION OF MICROSCOPICAL IMAGES. — Professor Abbe, of Jena, has lately[2] established a conception of the manner by which images are produced in the microscope, which is entirely different from those usually adopted. The microscopical image of the object is formed by the superposition of two images, which have an entirely different origin, and can in fact be conceived to be separated one from the other. One image is a *negative* one, by which all parts are represented as a geometrical likeness by the unequal emersion of the rays of light passing through the object. This image is called by Abbe "absorption image." It represents the *definition* of the microscope.

The other image (formed by as many partial images as there are bundles of rays which have been isolated from the cone of light, and pass into the object) is *positive*. It is an image produced by refraction, and represents the *penetration*, that is, the finer structure of the object. Wherever the structural elements of the object are small enough and approximated enough, phenomena of diffraction appear. The consequence is that structural images, produced by a coöperation of the fraction of the rays of light, are not in a constant connection with the real structure of the object which produced it, but in constant connection with the phenomenon of diffraction which brought about the image.

Microscopical images, therefore, showing systems of fine lines, as in diatoms, do not allow us to infer with safety the morphological existence of such structures, but only the existence of structures necessary to bring about such images. Consequently, the smaller the linear dimensions of a structure, the more unsafe are the conclusions respecting the real structure as indicated by the image. It can therefore never be decided with certainty by what sort of structure the systems of lines (as for instance those of *Pleurosigma angulatum*) are produced, nor will the image of the finer transverse lines of muscular fibres give certain conclusions about the arrangement of the finer details of structure. This want of certainty may also apply to differences in the degree of transparence of objects, their color and polarization.

Abbe's researches allow us to limit with certainty the powers of the microscope. "Never can parts be seen which are so nearly approximated that even the first bundles of rays of light produced by fraction are not able to enter the objective at the same time as the unbroken cone of light." Every aperture of the objective has a fixed limit for the smallest distance of objects by which it is possible to see the object.

Any new perfection of the microscope cannot go much further than to show for central illumination the whole length of one wave of blue light, and for the greatest possible oblique illumination half the length of a wave.

[1] This department is conducted by DR. R. H. WARD, Troy, N. Y.

[2] Archiv für mikroskopische Anatomie, 1873, ix. 413–468.

It may therefore be observed that no microscope will show any more of the structure of an object than it is possible to see by an immersion-objective of a power of two hundred diameters. Helmholtz[1] arrives at the same results by another mode, giving the smallest perceptible distances for the middle greenish yellow light, 0.000275 mill. $= \frac{1}{3636}$ mill. — H. HAGEN.

[We print this abstract of Professor Abbe's curious researches, though not without mental reservations in regard to some of its conclusions. — ED.]

TYNDALL ASSOCIATION. — The second annual "Science Exposition" of this active society was given at the City Hall, Columbus, on the evenings of December 7, 8, 9, and 10, 1875. A prominent part of the exhibition was the microscopy, in charge of the president of the microscopical section of the society, Rev. I. F. Stidham. Objects calculated to prove attractive to a popular assemblage were displayed upon microscopes furnished mostly by the members of the society, and an explanatory lecture was delivered on the first evening by Prof. A. H. Tuttle. The instruments, over thirty in number, were by nearly all the familiar makers, the following maufacturers being those that were represented by more than one each: Beck, Queen, Hartnack, Grunow, Ross, Zentmayer, Crouch, and Fields.

SONOROUS SAND. — The "musical beaches" which occur at some points on the New England coast and in Georgia, as well as at the more famous localities in Arabia, Switzerland, the Hebrides, and the Sandwich Islands, have lately been attracting much attention from microscopists. When handfuls or larger quantities of the sand are rubbed together, a musical sound is produced which seems to be due to the numerous microscopic pits or cavities which abound in the grains of sand. These pits are especially conspicuous and interesting in the Sandwich Islands sand. Moisture, which would temporarily obliterate the cavities, prevents the sound.

EXCHANGES. — A photograph of any specially interesting microscopic object will be furnished in exchange for the use of the object from which to obtain a negative. The object itself will be returned uninjured within one week. Address proposals to R. H. Bliven, Elmore, Ohio. — Double-stained vegetable sections in exchange for good mounted objects W. G. C., 103 Warren Avenue, Boston. — Slides of sonorous sand from Sandwich Islands in exchange for any good mounted objects. W. G. C., 103 Warren Avenue, Boston.

UNMOUNTED OBJECTS. — C. A. Baldwin has transferred the agency for distributing these objects to Prof. H. A. Ward's museum, Rochester, N. Y., from which they can be obtained in future.

J. W. QUEEN & Co. — The changes recently noticed in this firm refer only to the New York house.

[1] Ueber die Grenzen der Leistungsfähigkeit der Mikroskop, Monatsberichte der Berlin Akademie, 1873, page 625.